The International Journal of Nautical Archaeology (2006) **35**.1: 79–87
doi: 10.1111/j.1095-9270.2006.00090.x

The Greek-Norwegian Deep-Water Archaeological Survey

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From 1999 to 2003 the project surveyed the sea-bed in selected areas in Greece in order to locate marine cultural remains in depths below 50 m that have not been explored by divers. The project has shown that it is possible to perform systematic large-area surveys in deeper waters using off-the-shelf equipment from available small ships, at relatively low cost with good results.

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Key words: Survey, side-scan sonar, ROV, Greece.

Large areas of the Greek coastline have been examined by divers, and the Greek authorities have a database of approximately 1000 shipwrecks in shallow water. Very little is known, however, about sites in deeper water where conventional diving is impossible. The Greek-Norwegian Deep-Water Archaeological Survey is a joint project of the Greek Ephorate of Underwater Antiquities (EEA), the Norwegian University of Science and Technology (NTNU) and the Norwegian Institute at Athens (NIA). The main goal of the project is to develop and test in the field a set of practical and cost-effective remote-sensing methods that can be used by most archaeological institutions to locate sites in deeper water. From 1999 to 2003 the project surveyed the sea-bed in selected areas in Greece in order to locate marine cultural remains in depths below 50 m that have not been explored by divers (Fig. 1). The results of this survey constitute a new source for research activity and an effective tool for the Greek Ministry of Culture in its efforts to protect the underwater cultural heritage in the selected areas. This article is based on detailed annual reports by Agouridis *et al*. (2000), Delaporta *et al*., (2003) and Jasinski and Søreide (2004).

Survey methods

The Greek-Norwegian deep-water archaeological survey constitutes the first systematic use of underwater survey technology in Greek waters. One of the main goals of the project is to keep the costs to a minimum. Most authorities and archaeological institutions refrain from mapping their cultural heritage in deeper water due to the perceived high cost. Deep-water survey technology is often considered by archaeologists to be a fascinating but complex and expensive high-tech tool, and it is very seldom implemented in archaeological activities. This project was therefore designed to show that it is possible to perform systematic large-area surveys using existing equipment from small ships with a small crew at relatively low cost with good results (Søreide and Jasinski, 1998; Jasinski, 1999; Søreide, 2000). By locating and documenting underwater archaeological remains in deeper water the Greek authorities are building a database of deep-water sites that they can use for sound underwater cultural heritage management. This can hopefully stimulate similar activities in other countries.

Throughout the survey the project used a SeaScan PC high-resolution side-scan sonar system

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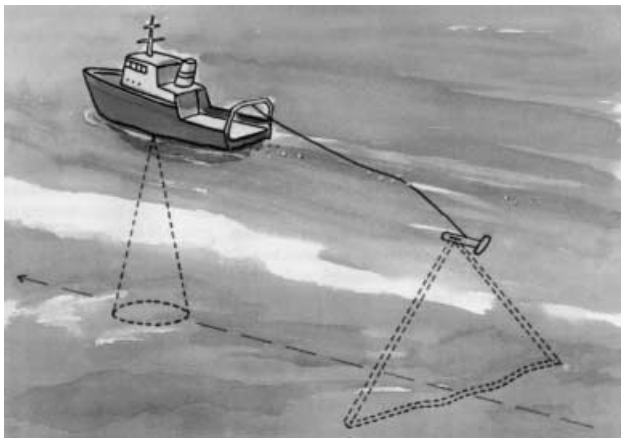

Figure 1. Operation with side-scan sonar.

Figure 2. Site locations.

from Marine Sonics Ltd operating at a frequency of 150, 300 and 600 kHz. This was towed behind a fishing vessel and used acoustic signals to construct an image of the sea-floor, and objects lying on top of the sea-floor (Fig. 1). The lower of the two frequencies was employed for large-area surveying, set at a range of 100 m to each side of the tow-fish and towed at a speed averaging 2.5 knots, 10 m above the sea-floor. The higher frequency, 600 kHz, was used for detailed site imaging of shipwrecks located during the large-area survey and was set at a range of 50 m to each side of the tow-fish and towed at a speed averaging 1.5 knots, 5 m above the sea-floor. The large-area survey covered nearly 200 km of survey lines.

The SeaScan PC side-scan sonar was operated by two of the project personnel for a total of six weeks during the three seasons that field research was undertaken. Data was collected on a portable computer and coupled with differential GPS. All targets were identified in real time and exported to a simple database programme to manage the several hundred anomalies detected throughout the course of the survey. In the evenings the sonar data was reviewed by the sonar operators and the database modified to highlight the most promising targets for further inspection at the end of the large-area survey.

For visual inspection of chosen targets the project used two ROV systems, a Sub-Fighter 4500 ROV from Sperre AS and a Falcon ROV from SeaEye Marine. Capable of operation to several hundred metres depth, these ROVs were equipped with scanning sonars and a variety of cameras to relocate sonar targets on the sea-floor. Additional equipment included a manipulator arm and a laser measurement system which uses two lasers positioned in parallel to project a scale of approximately 10 cm onto the sea-floor and into the video images. This scale can be used to measure distances in the image. GPS was used to position the ship and a Kongsberg Simrad HPR acoustic underwater positioning system was used to position the ROV relative to the ship on the surface. The position of the ship and of the ROV and targets located were fed into a PC-based navigation system. Three ancient shipwrecks were located during the fieldwork, while an additional 17 targets were inspected by ROV but were geological features.

Field activities in the Northern Sporades

A detailed study of geology, history and existing archaeological research was considered a necessary starting point to identify the most promising areas for the survey. The project's field activity was inaugurated in 1999. The islands of the Northern Sporades (Skiathos, Skopelos, Alonnesos, Kyra-Panagia, Gioura, Psathoura and a few other neighbouring islets) form an arc which starts at the Pelion peninsula and enters the North Aegean in a NNE direction. From the northern part of this arc the sea-bed drops abruptly to 100 m without morphological anomalies, followed by a zone with a depth varying from 100 m to 170 m, with a smooth inclination to the north, between Alonnesos and Psathoura. In general, the Northern Sporades are characterised by a great geomorphological variety and complexity. Geologically, limestone predominates in different forms.

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Despite differences of opinion regarding rates and timing of sea-level changes, there is a widely-acknowledged consensus that the global sea-level must have been 150 m lower than its present level at the last glacial maximum phase around 18,000 BC. Climatic warming related to deglaciation during the Holocene led to a world-wide marine transgression with the establishment of present sea-levels attained over the last few thousand years. The rapid rise slowed down around 7000 BC, while over the last 3000 years the increase has generally been gradual and in the order of several metres at the most. Archaeo-geological research in the Aegean shows that in the last 4000 years the sea-level must have been between +3 m and −5 m compared to the present level (Flemming *et al.*, 1973; Bird and Fabri, 1987).

Archaeological background

The need for raw materials and marine resources turned the first inhabitants of the Aegean towards the sea. Earliest evidence of seafaring come from the Franchthi cave in the Argolid (Peloponnesos), where obsidian from Melos was found in strata dated around 9000 BC. This valuable volcanic rock was distributed from Crete to Macedonia, implying deliberate sea voyages at that early date. However, the earliest evidence of human presence comes from the Middle Paleolithic. Professor Dimitrios Theocharis was the first to discover upper Pleistocene deposits containing fossilised bones of big mammals and the remains of a local stone industry at the site of Kokkinokastro in Alonnesos. It was the first time that human presence was confirmed at such an early date in the Aegean archipelago. Furthermore, it was the first evidence that Homo sapiens occupied islands in the Aegean, which were separated from the mainland by shallow straits of water. It thus seems possible that some kind of craft was used for the crossing of these straits and for the transportation of domestic animals (Theocharis, 1970).

Recent excavations in the Cyclops cave, on the small, rocky and uninhabited island of Gioura, yielded evidence of human presence and activity from the 8th millennium BC (7800–7000) until Roman times. Fish bones of large species imply open-sea fishing, with the aid of an early kind of boat. Furthermore, it seems that the island served throughout the ages as an important landmark for navigation in the North Aegean area. Its height and distinctive shape would have guided mariners who ventured from the north-east Aegean islands and Macedonia to the entrance of the North Euboean gulf and Pagasitikos bay (Sampson, 1996).

The North and South Euboean gulfs have always been preferred for sea-traffic as they offer favourable conditions for navigation such as prevailing winds, calm sea and current generated from the tides. In this respect the cluster of the islands of the Northern Sporades were very important stepping-stones for communication of goods and ideas, bridging the two opposite shores of the North Aegean. Despite difficult meteorological conditions, the configuration of the coast provides important shelters for mariners. Their well-protected bays provided ideal havens for boats travelling from the N and NE, and *vice versa*. Furthermore, they served as bases of operation for pirates. Historians and locals talk about a wooden track connecting the two bays of the island of Kyra-Panagia (Planetes and Agios Petros), to enable the pirates to transport their boats from one bay to another and escape when they were trapped. Piracy started playing an important role in Aegean life from the Early Bronze Age onwards (Agouridis, 1997).

The northern group of the islands constituted the main fishing-ground of the whole Sporades region. Boats from as far as Volos, Trikeri, Skyros, and in some cases even from Euboea and Andros, had their temporary base in Alonnesos (bay of Steni Vala) during the summer months. Obsidian cores and blades from Melos have been found on the islet of Agios Petros in the south bay of Kyra-Panagia, and are together with pottery and some architectural remains proof of an Early Neolithic settlement. The site, now partly submerged, was discovered by Theocharis in 1970. The account of its discovery is quite fascinating as it is associated with the first systematic rescue excavation of a wreck in Greece. In 1970 ceramics looted from a Byzantine wreck (11th century AD) lying by the islet of Agios Petros in the south bay of Kyra-Panagia, appeared in foreign museums. Furthermore, a film was distributed showing the looters in action. This forced the Greek authorities to act immediately. The Ministry of Culture assigned the late Peter Throckmorton to carry out an investigation of the wreck under the supervision of the diving archaeologist Charalambos Kritzas. The project lasted three months and its aim was to map, excavate and raise all exposed finds, mainly fine-glazed decorated plates and commercial amphoras (Kritzas, 1971; Throckmorton, 1971). During the excavation Professor Theocharis visited the team, working from Throckmorton's *kaiki*, the *Stormie Seas*. His curiosity led him to the

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rocky islet of Agios Petros, where he first observed traces of the Neolithic site and collected stone axes and obsidian blades. The site was excavated and published by Nikos Efstratiou (1985).

Although large numbers of Bronze Age pottery sherds are scattered all along the eastern coast of Alonnesos (ancient ΙΚΟΣ), no important BA site has been located so far. As we know from literary sources, during the LBA Cretans colonised the islands of Skyros, Skopelos (ancient ΠΕΠΑΡΗΘΟΣ) and Alonnesos under the leadership of Staphelos (Greek word for wine) son of Dionysos and Ariadne, who introduced the cultivation of vine to the island (Doulgeri-Injessiloglou and Garan, 1990).

It is known from the rich archaeological record and the literary sources that the islands flourished during the classical period (5th–4th centuries BC), being mostly under Athenian control. Trade was then dominated by the Athenian fleet, which ranged from Massalia to Byzantium and the Black Sea, carrying mainly grain and wine in amphoras. Amphoras from Mendi (Chalkidiki in Northern Greece), Chios and Peparethos, together with fine Athenian ware, are the main cargo of numerous wrecks recorded by the EEA around these islands, showing that they have been part of the Athenian trade network (Brashinsky, 1962; Grace, 1979). The most important of these wrecks is that from Peristera dated to the late 4th century BC, investigated by the Ephorate since 1992 under the direction of Dr Elpida Hadjidaki, since it offers new information about ship construction and the economy of the 5th century BC. As the excavator argues, the cargo of approximately 4000 amphoras (weighing 28–37 kg each) requires a merchant vessel capable of carrying more than 100 tons burden (Hadjidaki, 1996). It seems that such vessels were not uncommon from the 5th century onwards. This argument was supported previously by Lionel Casson (1971). Equally important is the wreck investigated by the islet of Phagrou (or Pelerissa) in the bay of Agios Petros at the island of Kyra-Panagia, very close to the Byzantine wreck mentioned above, with a cargo of Mendian amphoras dated to the middle of the 5th century BC, as it is the earliest classical wreck ever found (Haniotis, 1994).

The history of the area seems to be the same in the centuries that followed. However, archaeological finds are more abundant from the Early and Middle Byzantine periods (6th–12th centuries AD). Apart from architectural remains of Byzantine basilicas and ceramics scattered everywhere on the islands, it should also be noted that the fortification walls of the main citadel of Alonnesos (Chora) were constructed then and later repaired by the Venetians. Near the east coast of the island of Kyra-Panagia, 4 km from Agios Petros bay, lies a Byzantine monastery built in 900 AD. It is a *metochi* of the monastery of Megisti Lavra of Athos. The whole island was bought by Megisti Lavra and has since then belonged to the religious state of Athos. Traces of Late-Roman and Byzantine occupation can be seen all over the island. Several Byzantine amphora wrecks recorded by the Ephorate, dated to the 11th and 12th centuries AD, show an increase of commercial activity in the area during the last thriving period of the Byzantine Empire. During the Middle Ages the islands were dominated by the Venetians, who competed with the pirates and the Ottomans for the control and the safety of this very-frequented sea route.

Results of the survey

The survey was primarily carried out using towed side-scan sonar as described above. To familiarize the Norwegian crew with the characteristics of ancient shipwrecks in Greek waters, the side-scan sonar was first used to relocate five known shipwreck sites reported by the Greek Ephorate of Underwater Antiquities. This allowed the Norwegian team to calibrate the sonar equipment to the local conditions, such as underwater topography, and wreck-site appearance. The survey was primarily carried out in two areas, Area 1 covering Agios Petros Bay on Kyra-Panagia Island and Area 2 covering the west coast of Peristera Island. Of the five known sites, two were located in Area 1 and three in Area 2. The first target in Area 1 was a shipwreck from the classical period, which was excavated by Greek authorities under the direction of F. Haniotis in the 1990s. This is the oldest known Classical shipwreck in the Aegean Sea, dating to *c*.450 BC. The site now consists of approximately 50 amphoras visible on the sea-bed. The other known wreck in Agios Petros Bay was from the Middle Byzantine period (*c*.1050 AD). It was partly excavated in 1970 by the Greek Ministry of Culture under the direction of Charalambos Kritzas and the late Peter Throckmorton. The sonar, however, had difficulties detecting this wreck-site due to the fact that only approximately 35 scattered amphoras are visible on the sea-bed, which was characterised by a complex underwater topography. This made it extremely difficult to separate single amphoras from the terrain. In Area 2 the first site was a large classical shipwreck (the 'Alonnesos wreck') which has been investigated by the Greek authorities under the direction of

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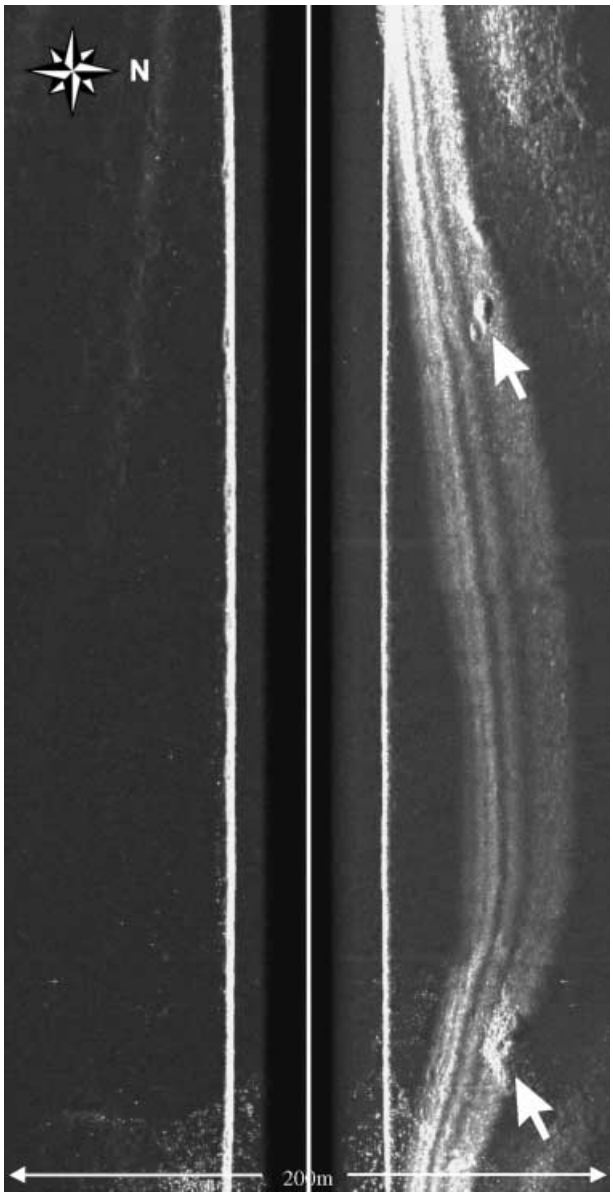

Figure 3. The 'Alonnesos wreck' (bottom arrow) and the remains of a small Byzantine shipwreck (top arrow).

Dr Elpida Hadjidaki. The site consists of a large amphora mound, which was easily detected by the side-scan sonar (Fig. 3). The two final positions were located in Vasiliko Bay on Peristera Island. This site consists of two large Byzantine shipwreck amphora mounds lying close to each other. These two wreck-sites were also easily detected by the sonar.

These test surveys proved that the side-scan sonar system could be used to detect the amphora cargoes of the known ships. Based on these attempts it was concluded that both the underwater topography, the size of the amphora mound and the sonar frequency are determining parameters for locating this type of marine archaeological site. The relatively flat and sandy sea-bed in Area 2, together with large amphora mounds, made it possible to use the long-range, medium-resolution (150 kHz) sonar to locate sites and create acceptable images. In Area 1 the difficult underwater topography with rocks and varying depths, together with the low number of amphoras visible on the surface of the sea-bed, necessitated the use of the higher-resolution/shorter-range 600 kHz sonar.

Following this calibration of the equipment the crew continued with a limited survey in selected areas off Peristera island. This concentrated on water-depths beyond the diving limit, primarily from 50 m to *c*.100 m, an area where there had been no surveys earlier, and resulted in several new discoveries. Approximately 200 m from the 'Alonnesos wreck' the sonar detected a fairly small (*c*.8 m-long) feature which was consistent with an amphora mound. Diving inspections later confirmed that this is a small Byzantine shipwreck. Another interesting sonar feature was discovered only a few hundred metres away from the two known Byzantine wrecks in Vasiliko Bay on Peristera Island. This target was verified during the survey by the Greek divers as a Byzantine shipwreck (Fig. 4). The site was found to consist of at least several hundred early-12th-century amphoras and is located in nearly 60 m depth (Figs 5 and 6). Several other interesting targets were also detected, and will be verified by diving inspections in the future.

Field activities in the Ionian Sea

In 2000–2003 field activities were shifted to the Ionian Sea. It was decided that the project would make a complete and systematic large-scale survey of the sea-floor around Ithaki, in depths beyond the reach of divers, primarily between 40–50 m to about 100 m. Large areas of the sea-floor around the nearby island of Kefalonia have also been included (Figs 1 and 7). This area was an important station on the ancient trade route to Italy.

Topography, archaeology and history of Ithaki

The 23-km-long island of Ithaki runs south to south-east, parallel to Kefalonia, in whose shadow it has always lain. Its surface area is 86.4 km^2, with a fairly even width of 6 km, except for the 600-m-wide isthmus where Molos Gulf cuts deeply into the coast. On this isthmus stands the 378-m-high Mount Aetos. The topography is dominated

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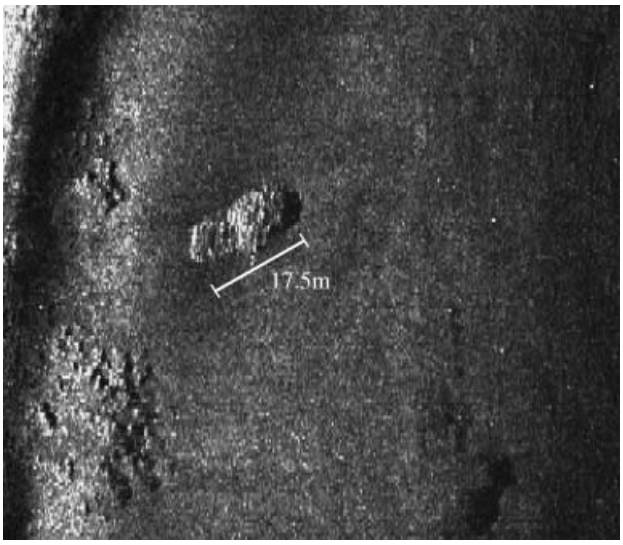

Figure 4. Sonar image of the Byzantine shipwreck that was discovered in Vasiliko Bay.

Figure 6. Amphoras from the wreck-site.

Figure 5. The amphora mound of the Byzantine shipwreck in Vasiliko Bay.

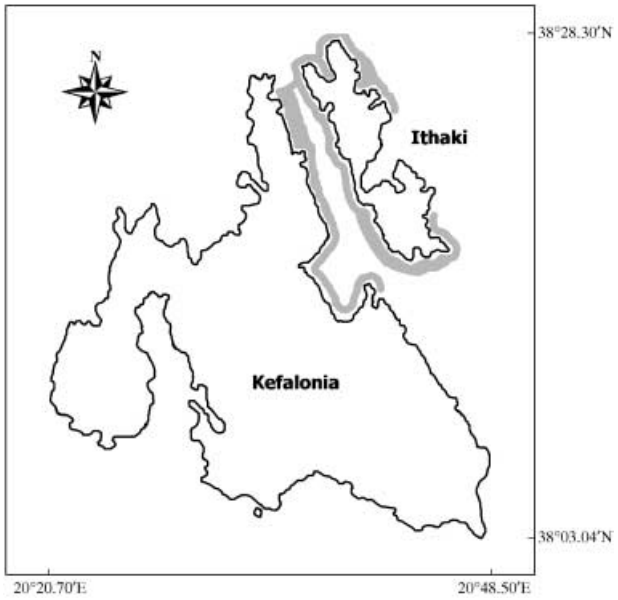

Figure 7. Site location and survey coverage.

by Nirito (or Anogi) Mountain (809 m high) on the northern half of the island, and Nerovoulo Mountain (669 m) on the southern half. Both fall abruptly into the sea to the west, and Nirito does likewise into Molos Gulf. To the north and north-east and in the entire southern half there is room for foothills along the coast, creating terraces and valleys, forming two habitation and agricultural zones, one at each end of the island. The sole plain is the narrow 3-km stretch of Kampos at Vathy (Philippson, 1958: 492, 495).

The coast is rocky, although without appreciable cliff-formation due to the absence of rock-carving breakers. The west coast has only two small bays; in the north Polis, a round basin of some 30 m depth behind a headland, and further south, Piso Aetos on the Aetos isthmus, where the coast falls back about 1 km creating a wide, open bay with no protection. On the east coast the land cascades abruptly into the sea, with the 200-m mark only 200–300 m offshore. It is repeatedly slashed by bays: Afales at the north end, Kourvoulia and Schoinari with the harbour town of Frikes, and the wide bay of Kioni. On the eastern shore of Molos Gulf the narrow, deep bay of Vathy creates the best harbour on the island. The southern half of

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the east coast has five bays, Filiatro, Sarakiniko, Agia Sofia, Palia Lygia, and Kaminia. Due to substantial water depths the bays of Ithaki do not offer advantageous modern anchorages. The channel between Ithaki and Kefalonia is 2.5-km wide at the northern end, and widens southwards to 5 km. The average water depth is *c*.150 m, with 110–120 m at the south end. There are no rocks or shallows except for the islet of Daskalio (incorrectly identified with the Homeric Asteris). These favourable characteristics are somewhat tarnished by irregular currents and gusty winds coming off the high coast (Philippson, 1958: 492–4).

Geologically, Ithaki consists of a core of lime and flysch (a thinly-bedded sedimentary deposit of shales and marls, alternating with coarser sandstone and conglomerate strata) covered with hills of late tertiary sediment By virtue of this predominance of limestone, the island is largely bereft of water. As a result, two thirds of Ithaki is barren. Ithaki was once thickly wooded with oak. Today the island is almost entirely deforested, much of it being covered with thick *macchi*. The unwilling soil makes for poor cultivation potential, further enhanced by the predatory economic policy initiated by the Venetians, who took oil and salt, but restricted agriculture to ensure dependence on other sources (Philippson, 1958: 495–7; Lienau, 1989: 273–5).

Ithaki is probably most famous for its connection with Homer's Odysseus, but whether Ithaki was the Homeric Ithaka remains beyond hard proof (Bürchner, 1916: cols2289–93; Strauch, 1998: col.1176; Philippson, 1958 discredits the idea, while Picozzi, 1976 accepts it). Nevertheless, the identification has spawned a substantial industry geared towards associating places described by Homer (who had a very vague notion of Ionian geography) with topographical features on the island. Currently at least two expeditions are hunting for Odysseus' palace, and 'the School of Homer' has been identified under the chapel of Agios Athanasios near Exogi (Philippson, 1958: 498; Picozzi, 1976).

Lying at the rear of the Greek mainland, the Ionian islands remained outside the main political spheres throughout antiquity. Although Corinthian imports appear by 800 BC, interests lay with Kefalonia and, especially, Kerkyra (Strauch, 1998: col.1176). Corinth did not, it seems, establish a colony on Ithaki (Morgan, 1988: 315), and did not, as could be expected given Corinthian interests in the area, introduce the alphabet to Ithaki, where it appears not later than 700 BC—this appears to be the work of the Akhaians (Waterhouse, 1996: 309). Due to the poor agricultural resources, maritime trade constituted the prime support for the population. However, Ithaki, or popularly Thiaki, with little change in the name over the centuries, except for the Italian designation of Val di Compare or Cefalonia Piccola (Philippson, 1958: 491), was of minor importance to the cultural development of ancient Greece (Lienau, 1989: 275). In later antiquity Ithaki followed the fate of Kefalonia, thus becoming a member of the Aitolian Confederation in 226 BC, being declared a *civitas libera* by Rome in 189 BC, and then belonging first to the province of Achaia, then to that of Epiros during the Roman Empire (Strauch, 1998: col.1176). As a result, the Ionian islands became a station on the ancient trade route to Italy (Morgan, 1988: 315; Waterhouse, 1996: 315–7; Strauch, 1998: col.1176).

In the Middle Ages a gradual decline set in, leading to depopulation, and at the end of the Byzantine era (12th century), Ithaki was a notorious pirate lair (Philippson, 1958: 500–01). At the collapse of the Byzantine Empire, Ithaki came into the hands of Venice following the Fourth Crusade (Lienau, 1989: 274). The Venetians resettled the island with settlers from Lefkas (Philippson, 1958: 501). In 1479 Ithaki was attacked by the Turks, but was never to fall under the Ottoman yoke (Kallinikos and Dendrinos, 1989: 11). Ithaki remained under Italian masters until the Napoleonic Wars, when in 1797 the island was occupied by France. In 1799 it fell to Russia, who created the 'Republic of the Seven United Islands' (Ionian islands plus Kythera). In 1807 the Ionian islands were conquered by France, in 1809–10 by Britain, and became at the Congress of Vienna, in 1815, the 'United States of the Seven Ionian Islands', placed under British protection. Britain ceded the Ionian islands to Greece in 1864.

Results of the Ionian Sea survey

The side-scan sonar was used to survey large areas along the coast of Ithaki and Kefalonia (Fig. 7). By the end of the 2003 season, the Greek-Norwegian deep-water archaeological survey had completed a large-scale systematic sonar survey of the area, providing a catalogue of acoustic images of the sea-bed. Several sonar targets were considered potential shipwreck sites. To investigate these further, the team deployed an ROV. The main discovery was made towards the northern end of the sound between Ithaki and Kefalonia. Based on images from the side-scan sonar and a tip from

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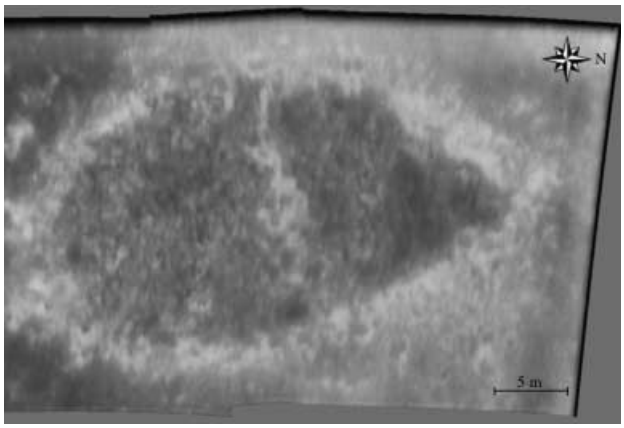

Figure 8. Photomosaic of the Roman wreck.

Figure 9. Amphoras from the Roman wreck.

a fisherman who occasionally caught amphoras in his nets, the ROV was deployed to carry out a systematic survey in the area. A large continuous amphora mound was located at approximately 60 m depth (Fig. 8). The wreck is more than 25 m long with a cargo of several thousand amphoras (Figs 9 and 10). These indicate that the wreck is Roman and dated between the 1st century BC and the 1st century AD. This discovery underpins the assumption that these islands were a stepping-stone on the important trade route to Italy. The ROV was used for video and photo documentation of the site. It was also used to document a known shipwreck from the 4th century BC, situated in depths of between 20 and 30 m, near the village of Fiscardo. Several additional sites located by the side-scan sonar have not yet been investigated by ROV.

Figure 10. Amphoras from the Roman wreck.

Conclusions

The Greek-Norwegian deep-water archaeological survey has shown the potential for archaeological studies in deep water in Greece. There is a remarkably high number of deep-water sites. They have not been looted by divers, and their archaeological significance creates an opportunity to extend knowledge and understanding of the maritime cultural processes that have taken place in this part of the Mediterranean. The surveys have focused on important ancient and medieval trade-routes in the Aegean and Ionian Sea, and have already resulted in the discovery of several new and significant sites. The project has so far provided a catalogue of acoustic images of the sea-bed and underwater archaeological sites in the selected survey areas. The Greek-Norwegian deep-water archaeological survey constitutes the first systematic use of such survey technology in Greek waters. The results are stored in a GIS database which will constitute a new source for research activity and an effective tool for the Greek Ministry of Culture in its efforts to manage and protect underwater cultural heritage.

The project has also shown that it is possible to perform systematic large-area surveys using existing equipment from available small ships, at relatively low cost with good results. Six weeks of survey work, covering nearly 200 km of survey lines, were completed at a cost of only approximately $100,000. This can hopefully stimulate similar mapping activities in other countries.

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Acknowledgements

This project could not have been carried out without the support of DnV, Telenor, Sarantitis & Partners, SeaEye Marine Ltd and Sperre AS.

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